

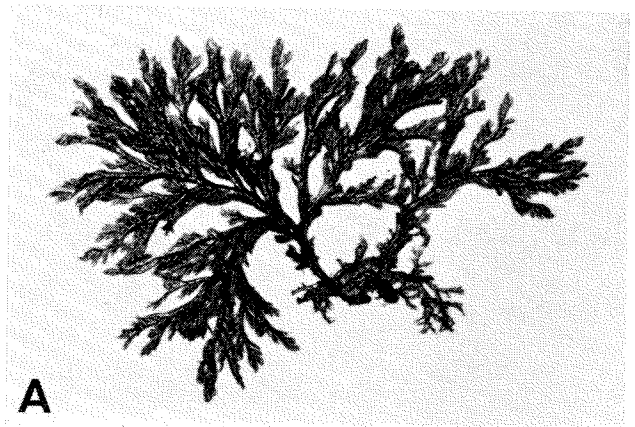
Fig. 2. Underwater suction sampler showing the filtering compartment with open lid, the inhalation tube to the right and the high pressure air tank connected with the exhalation tube. (Courtesy of Jóhannes Briem.)

ever, only a few species were of ecological importance. In the littoral zone two belts could be recognized, an upper one of *Urospora penicilliformis*, intermixed with various accompanying species, and a lower one of colonial naviculoid diatoms in a mucilaginous matrix. The sublittoral vegetation was dominated by *Alaria esculenta* populations. This situation, as compared to that known in mature algal communities of adjacent islands, indicated that the marine algal colonization of Surtsey was yet in its pioneer stage.

This paper deals with further observations on the marine algal settlement at Surtsey carried out in 1971 and 1977.

PROCEDURES OF INVESTIGATION

In 1971 the period of investigation extended from 20 to 30 August. Studies were carried out from the field station on Surtsey. The shore was explored at low tide by landing parties and the sublittoral zone by divers. The littoral zone was surveyed all around the island except for the south coast which was quite inaccessible. In the sublittoral zone 10 transects were investigated from 0-30 m depth (Fig. 1). Dives were made at 5, 10, 20 and 30 m depth and specimens were handcollected into plastic pails with cross-cut lids. The depth was measured with a wrist gauge. The nature of the bottom and the general features of the algal vegetation were recorded after each dive. The identification of species was made on fresh material. The nomenclature is mainly according to Caram and Jónsson (1972). Herbarium specimens were prepared and species photographed for later reference.



A



B

Fig. 3. A. *Plocamium cartilagineum*. Sterile plant from 10 m depth east of Surtsey, July 11 1977; nat. size 6 cm.

B. *Lomentaria clavellosa*. Plant from 20 m depth south of Surtsey, July 11 1977; nat. size 17 cm.

In 1977 the field work was performed from R/V Árni Fridriksson from 9 to 11 July in a similar way as described above. During this short survey investigations were limited to 3 subtidal transects, located off the east, west and the south coasts of the island (Fig. 1). Due to inaccessibility only the east and the west coasts could be explored by landing parties. Most of the material collected was fixed aboard the ship in 2% for-

TABLE I Vertical and horizontal distribution of marine algal species found in Surtsey waters in 1971 and 1977.

Species	Littoral	Sublittoral			1971			1977		
		0-10	15-20	30 m	E	S	W	E	S	W
RHODOPHYCEAE										
<i>Rhodochorton purpureum</i>	..	×	×
<i>Plocamium cartilagineum</i>	..	×	×
<i>Rhodophysemma elegans</i>	..	×	×	..
<i>Euthora cristata</i>	..	×	×
<i>Lomentaria clavellosa</i>	..	×	×	×	..
<i>Lomentaria orcadensis</i>	..	×	×	×	×	×	×
<i>Antithamnion floccosum</i>	..	×	×	×	×	×	×	×	..	×
<i>Antithamnion plumula</i>	..	×	×
<i>Delesseria sanguinea</i>	..	×	×	×	×	×	×	×
<i>Phycodrys rubens</i>	..	×	×	..	×	×	×	×	×	×
<i>Polysiphonia urceolata</i>	..	×	×	..	×	×	×	×	×	×
<i>Porphyra umbilicalis</i>	×	×	..	×	×	..	×
<i>Porphyra miniata</i>	..	×	×	..	×	×	..	×	×	×
<i>Conchocelis rosea</i>	..	×	×	×	×
PHAEOPHYCEAE										
<i>Ectocarpus siliculosus</i>	×	×	×	..
<i>Ectocarpus fasciculatus</i>	×	..	×	..	×	..	×	×	..	×
<i>Giffordia granulosa</i>	×	..	×
<i>Giffordia ovata</i>
<i>Giffordia recurvata</i>
<i>Giffordia secunda</i>	..	×	×
<i>Petalonia fascia</i>	×	×	×	..	×	×	×	×	..	×
<i>Petalonia zosterifolia</i>	×	×	..	×	×	..	×
<i>Scytosiphon lomentarius</i>	×	×	..	×
<i>Ralfsia</i> sp.	×	×
<i>Desmarestia aculeata</i>	..	×	×	×	×
<i>Desmarestia ligulata</i>	..	×	×	..	×	×	×	..	×	..
<i>Desmarestia viridis</i>	..	×	×	..	×	×	×	×	×	×
<i>Chorda filium</i>	..	×	×
<i>Chorda tomentosa</i>	..	×	×
<i>Laminaria hyperborea</i>	..	×	×	..	×	×	×	×	..	×
<i>Laminaria digitata</i>	..	×	×
<i>Alaria esculenta</i>	×	×	×	..	×	×	×	×	×	×
CHLOROPHYCEAE										
<i>Codiolum gregarium</i>	×	×	..	×	×	..	×
<i>Urospora penicilliformis</i>	×	×	..	×	×	..	×
<i>Ulothrix consociata</i>	×	×
<i>Ulothrix pseudoflaccida</i>	×	×	..	×	×	..	×
<i>Ulothrix subflaccida</i>	×	×
<i>Enteromorpha prolifera</i>	×	×	..	×	×	..	×
<i>Enteromorpha compressa</i>	×	×
<i>Ulva lactuca</i>	..	×	×
<i>Monostroma grevillei</i>	..	×	×	×	×	×
<i>Acrosiphonia spinescens</i>	×
<i>Derbesia marina</i>	..	×	×	..	×	×
<i>Pseudentoclonium submarinum</i>	×	×
CYANOPHYCEAE										
	×	×	×

malin seawater and analyzed ashore. In three instances plants and animals in the sublittoral zone were loosened from the bottom by a scraper and collected by an underwater suction sampler (Fig. 2) within quadrats measuring 25 x 25 cm (1/16 m²). This sampling process proved to be successful but was too time-consuming.

RESULTS

1. *Species survey*

The species composition of the macroscopic marine flora off Surtsey in 1971 and 1977 and the distribution pattern of individual species are summarized in Table I.

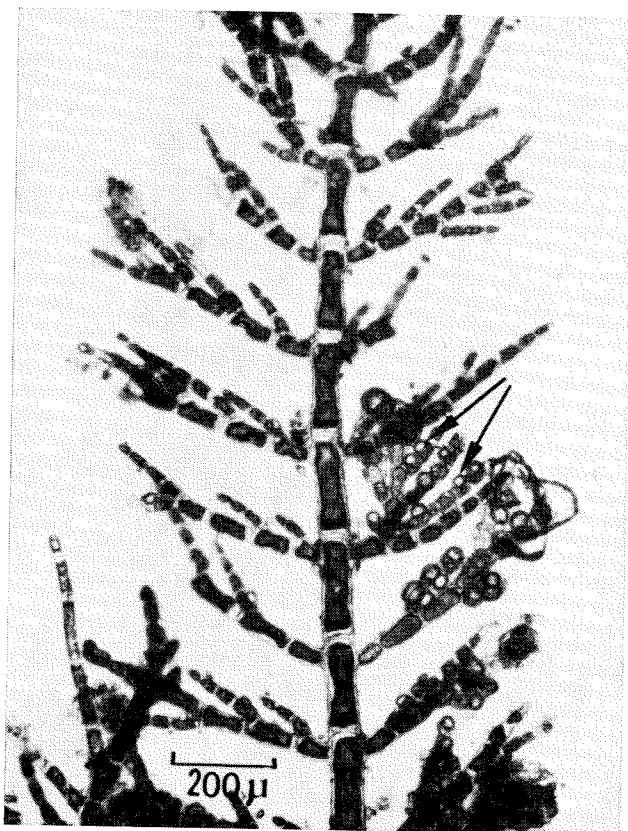


Fig. 4. *Antithamnion plumula* var. *boreale*. A part of sterile plant with gland cells (arrows); specimen from 10 m depth east of Surtsey, July 10 1977.

A total of 31 algal species were found growing in the coastal waters off Surtsey in 1971 and 34 species in 1977. The following 18 species were found for the first time, 8 species in 1971 and 10 in 1977:

Rhodochorton purpureum (Lightf.) Rosenv.

Two tetrasporiferous specimens were found in 1971 on *Desmarestia aculeata* collected at 8 m and 20 m depth off the west coast.

Plocamium cartilagineum (L.) Dixon

Some sterile specimens were found in 1977 growing at 12 m depth on rocks off the east coast (Fig. 3A).

Rhodophysema elegans (Crm. frat. ex J. Ag.)
Dixon

Patches of this species were found in 1977 at 10 m depth off the south coast where they grew on bare rocks. The specimens were 1-5 cm in diameter and had tetraspores between sterile nemathesial filaments on the surface of the thallus.

Lomentaria clavellosa (Turn.) Gaill.

Several plants of this species were found in 1977 at 10 m depth off the east coast growing on rocks amongst Hydrozoa. The largest specimen measured 20 cm and bore tetraspores (Fig. 3B).

Antithamnion plumula (Ellis) Thur. var. *boreale* (Gobi) Kjellm.

A few sterile specimens with typical gland cells (Fig. 4) were found in 1977 growing on hap-tera of *Laminaria hyperborea*.

Delesseria sanguinea (Huds.) Lamouroux

One sterile specimen partly covered with Bryozoa was found in 1971 on rocks at 20 m depth off the west coast. In 1977 this species was redetected at 10-30 m depth at the same locality (Fig. 5B).

Conchocelis rosea

This alga which is the sporophyte in the life history of *Porphyra* or *Bangia* was found in 1977 off the east coast at 10-20 m depth growing on mussels and calcareous Polychaeta tubes. It was sterile when collected.

Ralfsia sp.

In 1971 a small crust of the genus *Ralfsia* was found growing on the shore at the west coast amongst *Ectocarpus* and *Petalonia*. On one occasion *Petalonia* was found growing on the crust. The specimens were sterile.

Desmarestia aculeata (L.) Lamouroux

In 1971 one sterile specimen, 75 cm in length, was found on rock at 20 m depth off the west coast (Fig. 6). Another specimen found five days later in the same locality measured 60 cm.

Giffordia secunda (Kütz.) Batt.

This species was first detected in 1971 in a collection from 3-19 m depth off the SW-coast. The plants grew on rocks and bore ovoid plurilocular sporangia.

Giffordia recurvata (Kuckuck) Cardinal

This species which was not previously known from Iceland grew up together with *Giffordia ovata* and *Giffordia granulosa* in stock culture of *Derbesia marina* collected in 1977 at 10 m depth off the east coast. Our specimens attained a length of about 4 cm, and developed plurilocular sporangia (Fig. 7A). They agree with Cardinal's description of this species (Cardinal, 1964).

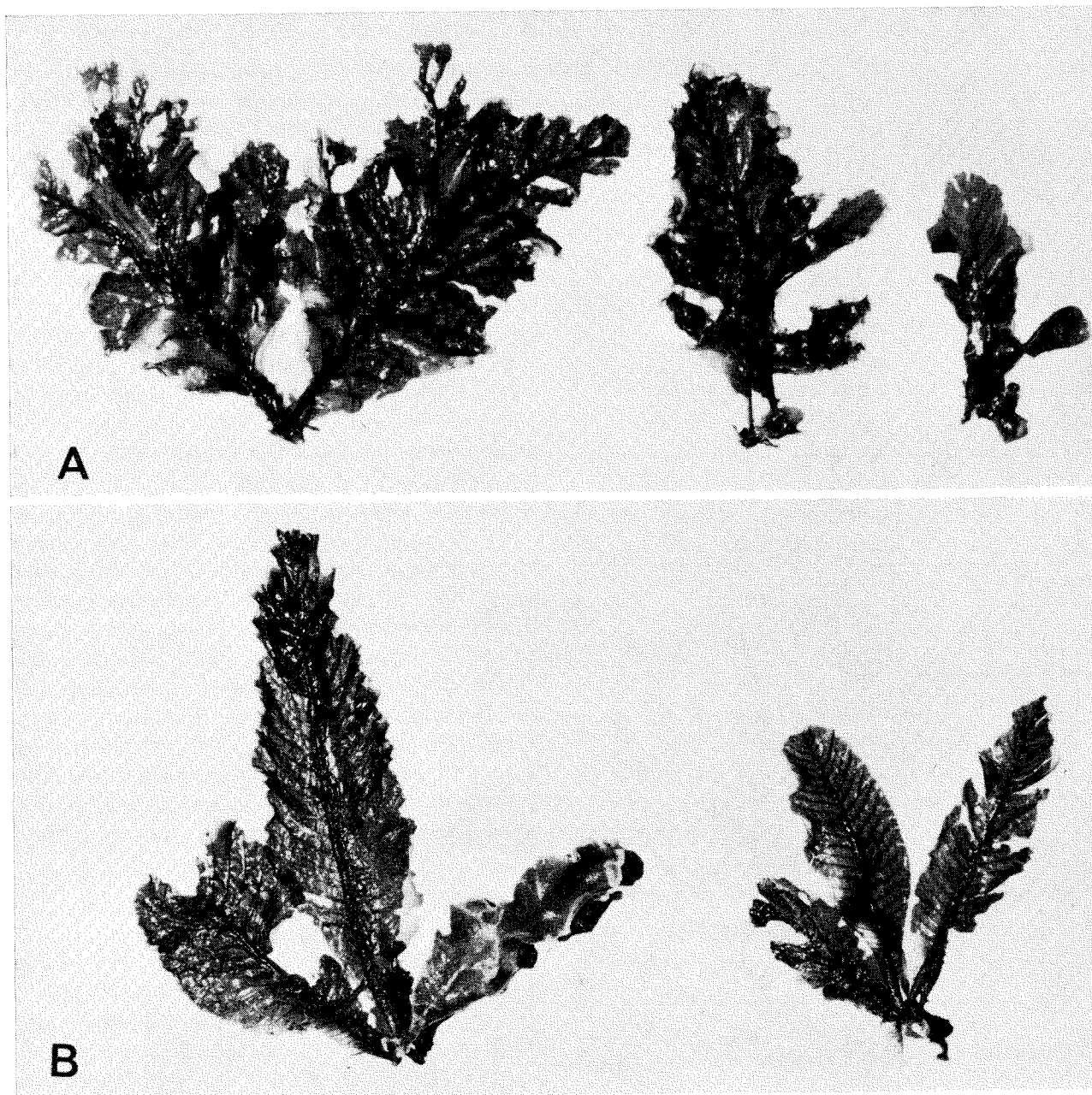


Fig. 5. A *Phycodrys rubens*. Different aspects of plants picked up from 20 m depth west of Surtsey, August 24 1971; max. nat. size 8 cm.

B. *Delesseria sanguinea*. Young (right) and old (left) specimens, the latter one covered partly by *Membranipora membranacea*; collected at 20 m depth west of Surtsey, August 24 1971; max. nat. size 7 cm.

Giffordia ovata (Kjellm.) Kylin

Typical specimens (Fig. 7B) bearing plurilocular sporangia grew up with the preceding species in stock culture of *Derbesia marina*.

Chorda filum (L.) Stackh.

This species which grew on stones amongst *Alaria esculenta* at 10 m depth was found for the first time in 1977 off the west coast. The plants were 60-70 cm long but sterile. This species has not previously been found growing in the Westman Islands.

Chorda tomentosa Lyngb.

In 1977 several scattered individuals bearing unilocular sporangia were found at 5 m depth on stones off the east coast. As the previously mentioned species this one has not been recorded in the Westman Islands before (Fig. 8B).

Ulothrix subflaccida Wille

This species was first found in 1971 on stones at high tide level on the west coast growing amongst *Ulothrix pseudoflaccida* and *Urospora penicilliformis*.

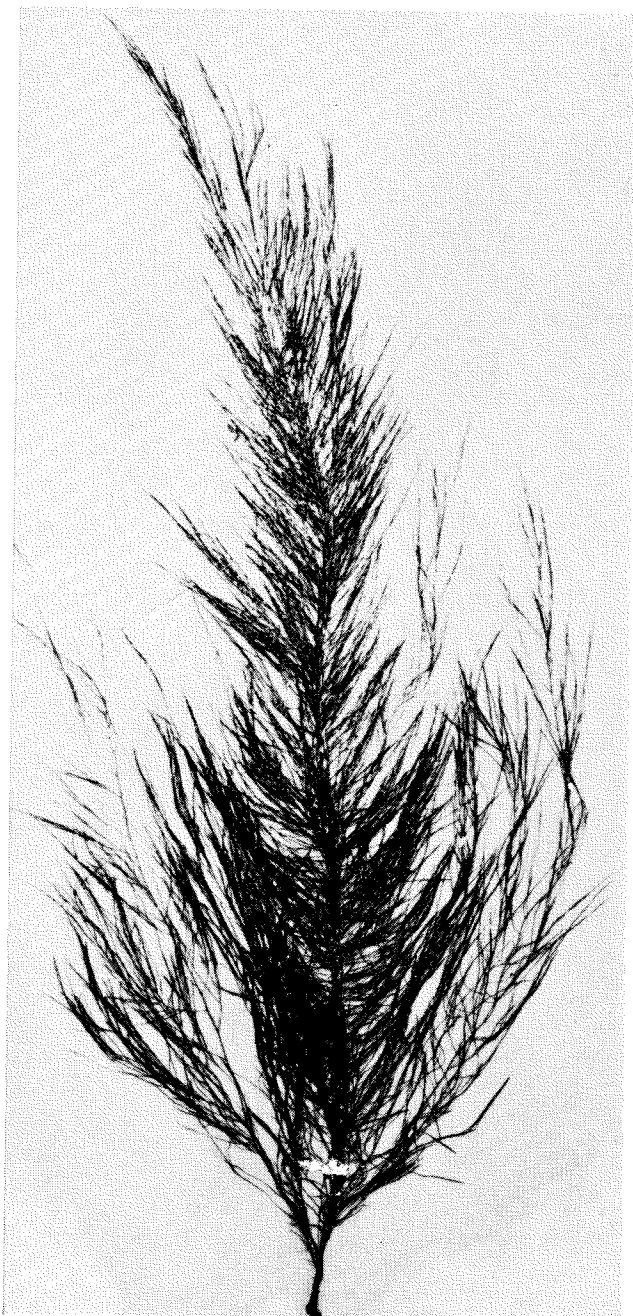


Fig. 6. *Desmarestia aculeata*. A fully grown plant from 20 m depth west of Surtsey, August 24 1971; nat. size 75 cm.

Derbesia marina (Lyngb.) Sol.

In 1971 some specimens were found growing on calcareous Polychaeta tubes at 6-10 m depth off the west coast. Some of these plants bore lateral sporangia (Caram and Jónsson, 1973).

Pseudentoclonium submarinum Wille

This species was found for the first time in 1971 growing on solid rocks above high tide level on the east coast.

Other species mentioned in Table I have been reported on previously (Jónsson, 1970a, 1972).

2. The vegetation

a. Littoral zone. The substratum of the littoral zone is mainly of three types: huge blocks bordering the lava cliffs of the west, south and east coasts with gravel and sand in between, the boulder terrace occupying the southeast and northwest coasts and sand forming the northern spit (Fig. 1).

In 1971 and 1977 there had been minor changes in the littoral vegetation from that reported in previous years, i.e. there were still two algal belts, a green one, located at high tide level, and a brown belt below. Between 1971 and 1977 *Alaria esculenta* was found to have extended its cover from the sublittoral zone into the brown belt of the tidal zone. The littoral vegetation appeared to be similar all along the rocky shore in both 1971 and 1977. No vegetation was found on the northern spit and a very scanty one on the boulder terraces. A total of 16 species have been found growing on the shore, the most conspicuous of these at present being *Enteromorpha prolifera*. Other common species are *Urospora penicilliformis*, *Ulothrix pseudoflacca*, *Petalonia fascia* (Fig. 9A), *P. zosterifolia* (Fig. 8A), *Porphyra umbilicalis* (Fig. 10A) and diatoms in mucilage threads. *Scytosiphon lomentarius* (Fig. 9B) is less common.

b. Sublittoral zone. The bottom from 0-30 m depth is of more or less uniform character around the island. It is mostly covered with big blocks of rock and boulders surrounded by gravel and sand. The rocky surfaces offer a suitable substrate for algal settlement. Around the northern spit the bottom is of sand and gravel with no visible vegetation.

In the sublittoral zone a total of 30 species were detected. Of these 19 were found in 1971 and 27 in 1977. In 1977 11 species were found growing in all transects and the most common of these were *Alaria esculenta* (Fig. 11), *Laminaria hyperborea* (Fig. 12) and *Desmarestia viridis* (Fig. 13). These species were associated with several species of red algae, i.e. *Phycodrys rubens* (Fig. 5A), *Delesseria sanguinea* (Fig. 5B), *Porphyra miniata* (Fig. 10B), *Lomentaria orcadensis* (Fig. 14A), *Polysiphonia urceolata* (Fig. 14B) and *Antithamnion floccosum*.

In 1971 *Desmarestia ligulata* (Fig. 15) was a conspicuous element of the submarine flora all around the island. In 1977, however, this species was found only off the south coast and represented by a few small individuals. On the other hand,

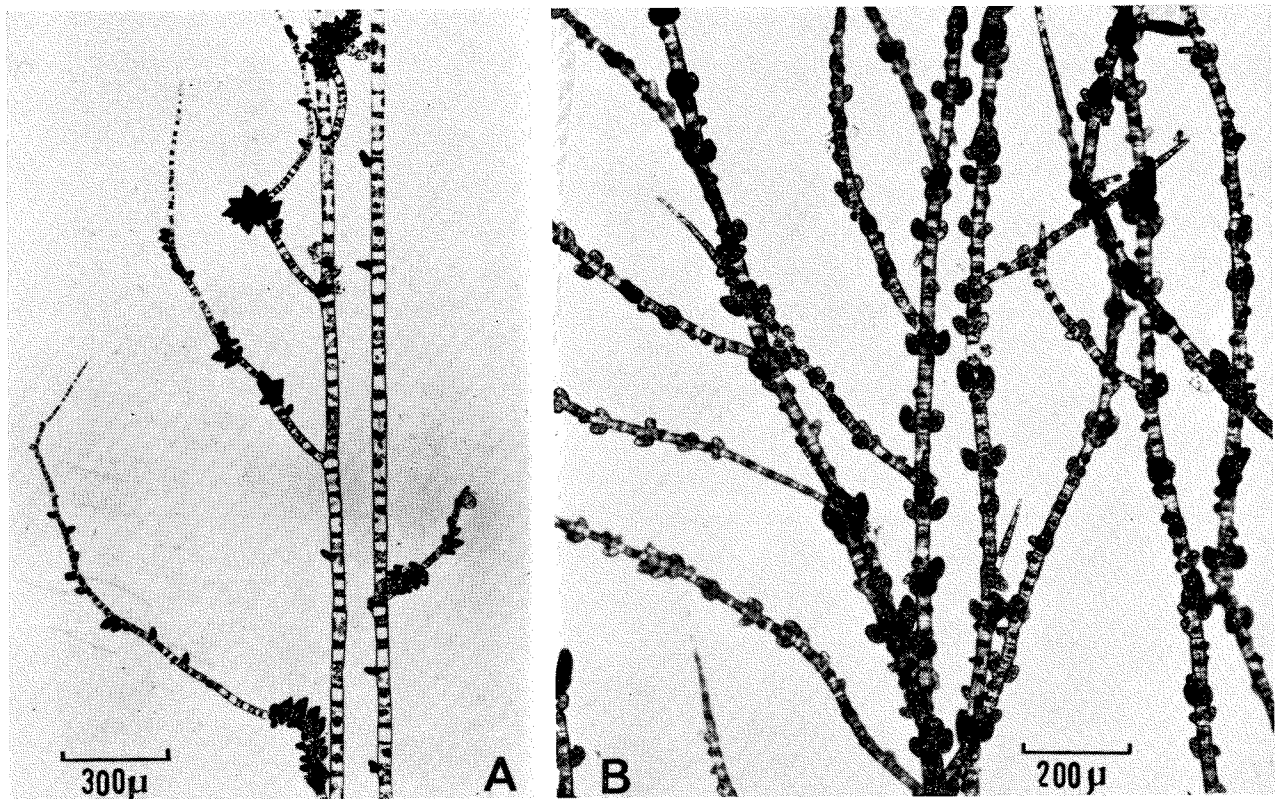


Fig. 7. A. *Giffordia recurvata*. A part of a plant with plurilocular sporangia; grew up in stock culture of algae collected at 10 m depth east of Surtsey, July 10 1977.

B. *Giffordia ovata*: part of a plant with plurilocular sporangia; grew up with preceding species.

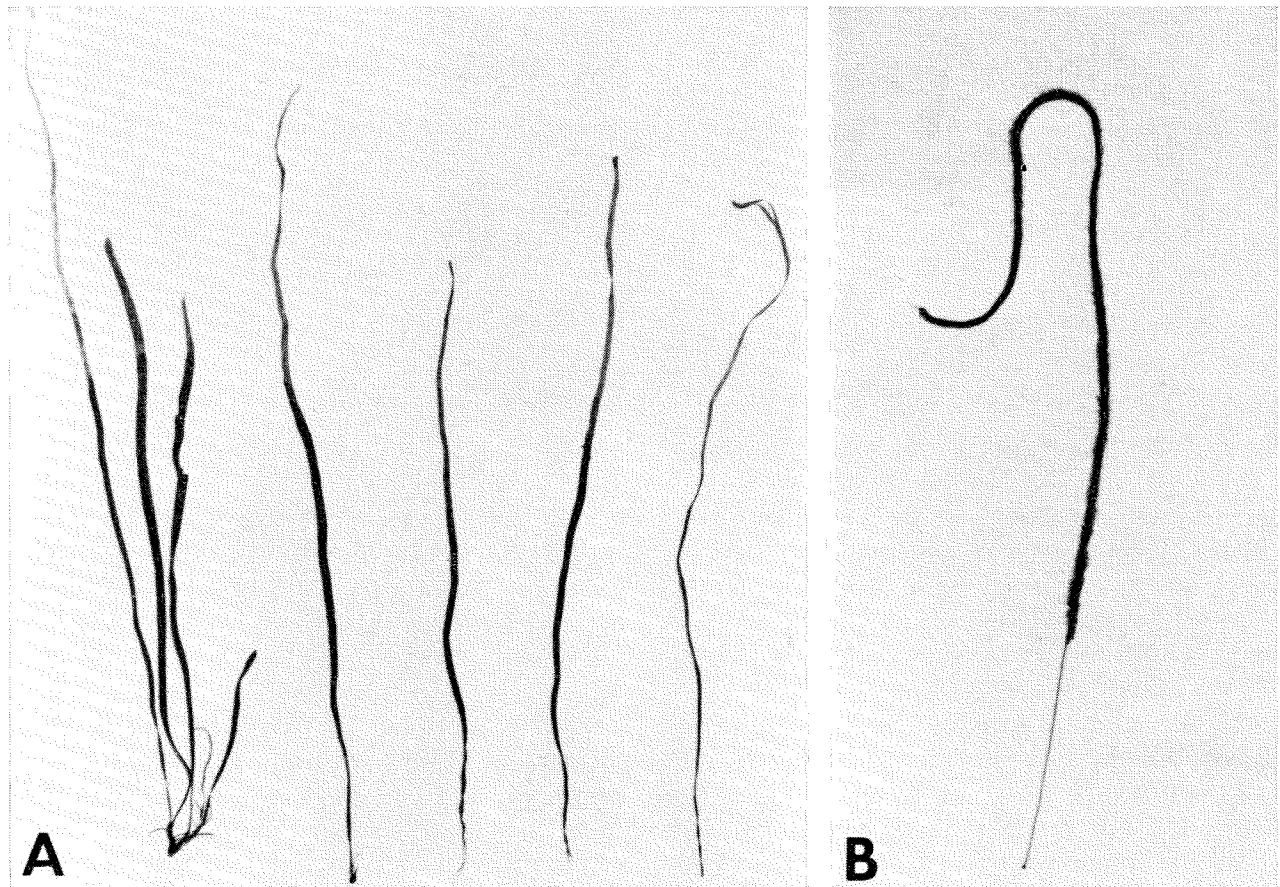


Fig. 8. A. *Petalonia zosterifolia*. Sterile specimens from the littoral zone on the northeast coast of Surtsey, July 9 1977; max nat. size 10 cm.

B. *Chorda tomentosa*. A fertile plant collected at 5 m depth northeast of Surtsey, July 9 1977; nat. length 32 cm.

Fig. 9. A. *Petalonia fascia*. A cluster of broad specimens collected in the intertidal zone on the southeast coast of Surtsey, August 27 1971; max. nat. size 4,5 cm. B. *Scytosiphon lomentarius*. A tuft of typical specimens from the intertidal zone on the east coast of Surtsey, August 23 1971; max. nat. size 6,7 cm.

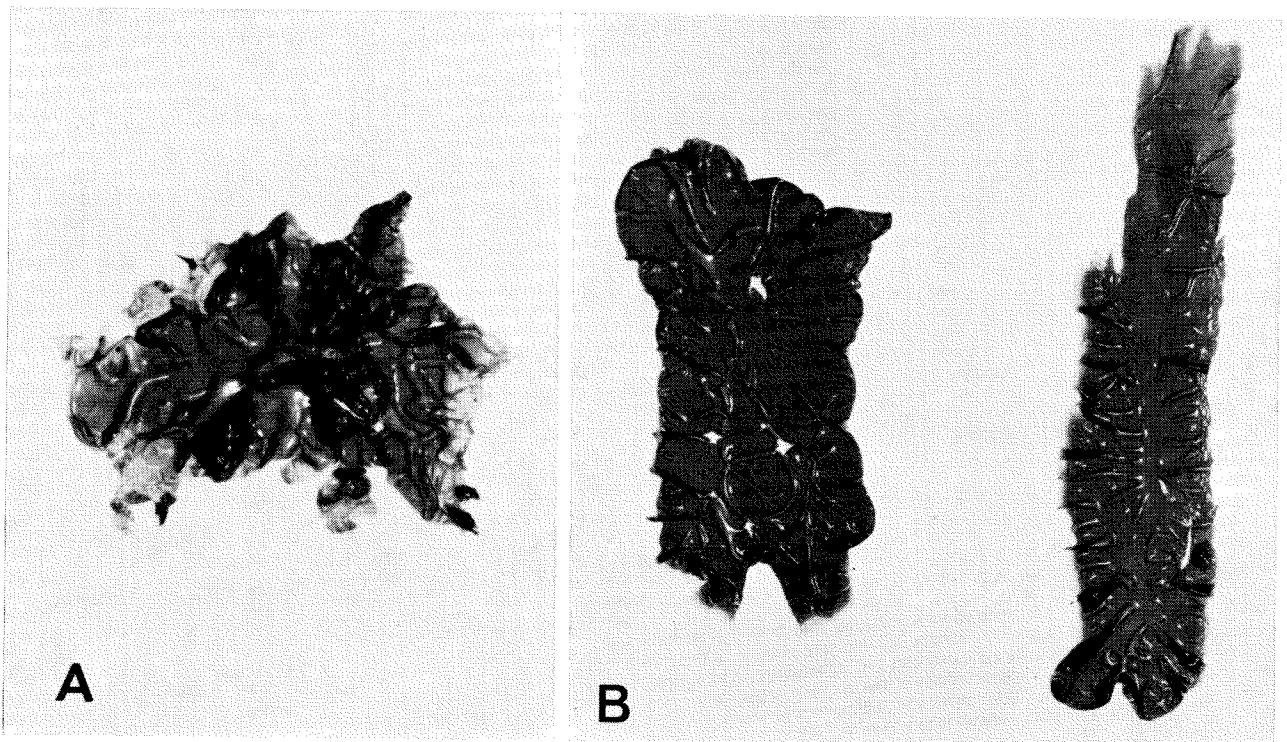
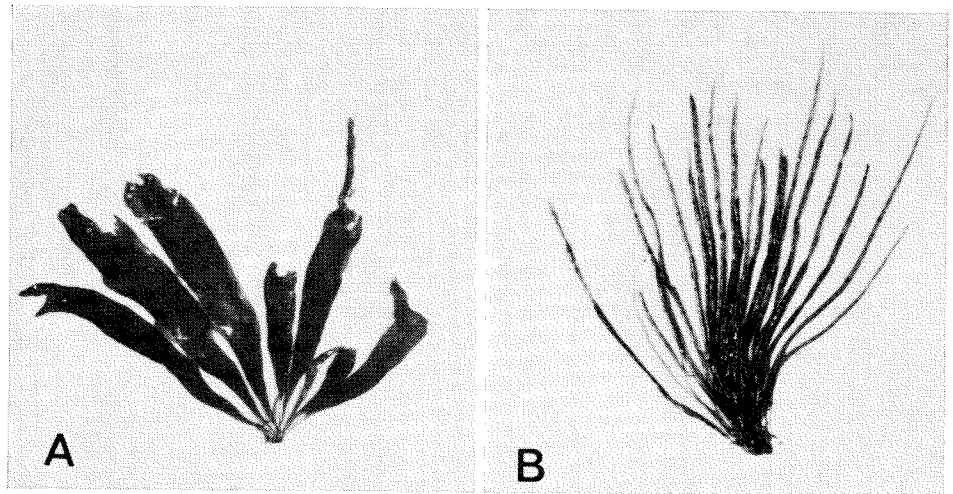


Fig. 10. A. *Porphyra umbilicalis*. A fertile plant from the intertidal zone on the east coast of Surtsey, August 23 1971; nat. size 4x7 cm. B. *Porphyra miniata*. Fertile plants from 5-10 m depth south of Surtsey, August 28 1971; max. nat. size 17,5 cm.

Derbesia marina and *Lomentaria orcadensis* had expanded since 1971. The former species was restricted to the west coast, but is now also growing off the south coast. *L. orcadensis* was in 1971 only found on the south coast but in 1977 it occurred in all transects.

In the sublittoral zone the algae were randomly distributed on rock surfaces at a depth range from 0 m to the lower limits of the vegetation at about 20 m depth, although few individuals could be found down to the depth of 30 m. This applies to both periods of observation. It was noted, that the *Alaria esculenta* populations were moving upwards, now occupy-

ing the lowest part of the tidal zone in several places. *Laminaria hyperborea*, first detected on the island in 1967, was found to be most often growing together with *Desmarestia viridis*. In 1971 the largest plants brought up from the bottom had a stipe length of 8-10 cm and the blades were 25-30 cm long. Similarly, the largest plants collected in 1977 measured 63-64 cm in stipe length and 52-66 cm in blade length. They grew at 15 m depth and were 5-6 years old. Their stipes are frequently covered with a luxurious growth of epiphytes. In addition to Hydrozoa and Bryozoa the following algal epiphytes were found on stipes and haptera of *Laminaria hyper-*

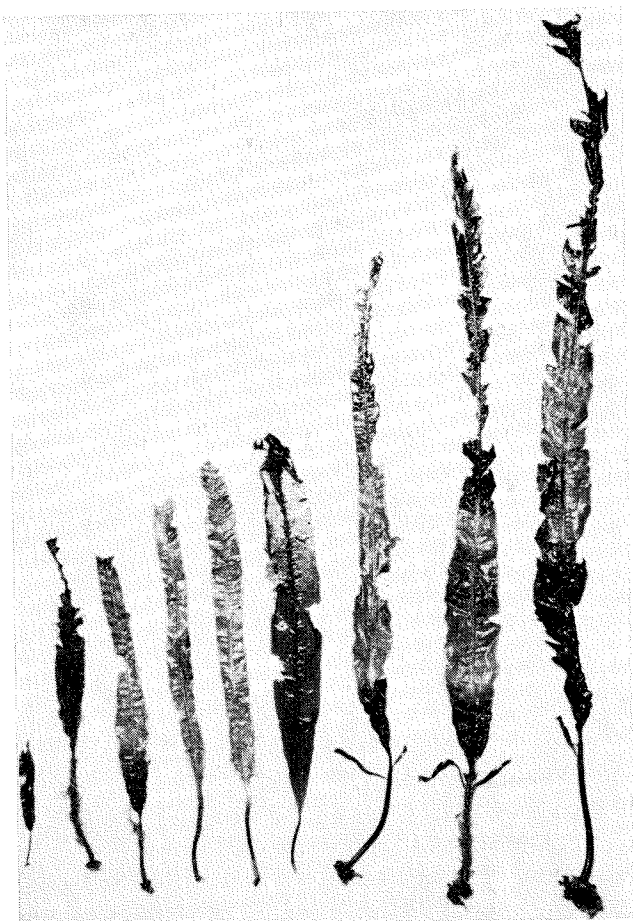


Fig. 11. *Alaria esculenta*. Growth variations in plants collected at 20 m depth west of Surtsey, August 24 1971; max. nat. size 62 cm.

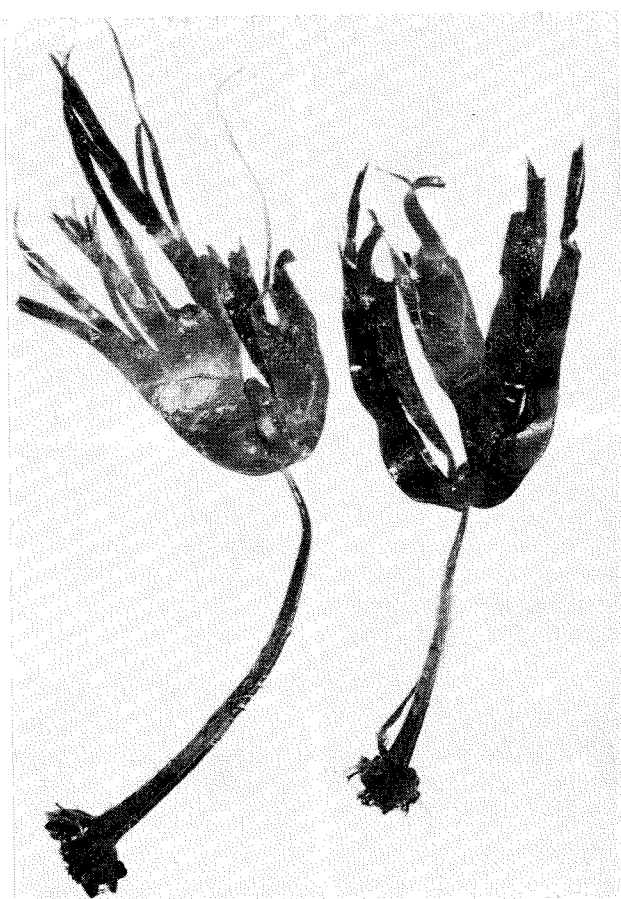


Fig. 12. *Laminaria hyperborea*. Well developed, typical specimens from 10 m depth east of Surtsey, August 28 1971; note epiphytes and epizoa on stipes and lamina; nat. size 85 cm.

borea: *Polysiphonia urceolata*, *Antithamnion floccosum*, *Callophyllis cristata* (= *Euthora cristata*), *Lomentaria orcadensis*, *Giffordia* sp. and *Alaria esculenta*. The blades are often covered with large patches of Bryozoa.

An estimate of the algal biomass at Surtsey could not be made during our short survey. However, samples taken with the underwater suction sampler within three quadrats at 10 m, 15 m and 20 m depth off the east coast revealed 7,9, 1,1 and 0,2 kg/m², algal biomass, respectively.

There are actually two major seaweed beds in Surtsey waters, located off the east and the west coasts of the island. In these two localities the eroding action appears to be somewhat less than elsewhere along the coast (Norrman et al. 1974).

DISCUSSION

All the new algal colonizers at Surtsey have been found in similar habitats on the coasts of Iceland with the exception of *Giffordia recurvata* which was not previously known from Iceland. This species is regarded as very rare in

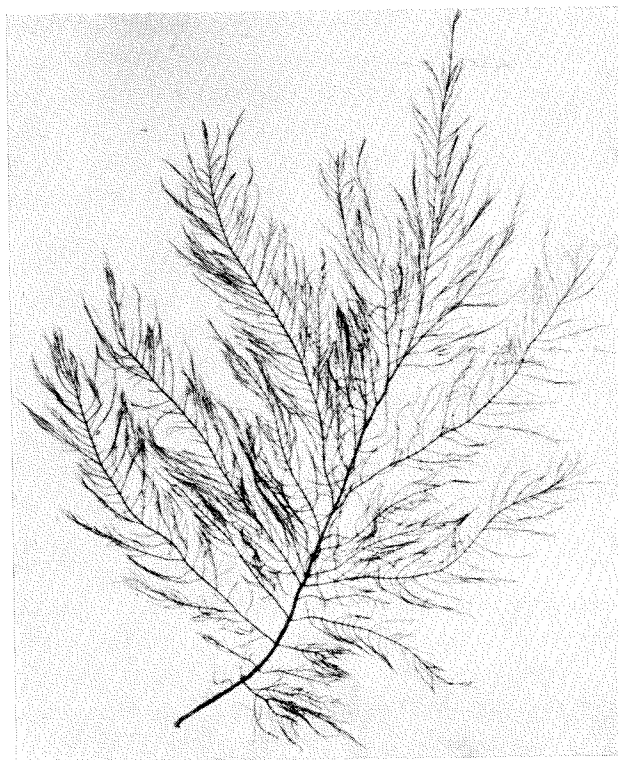
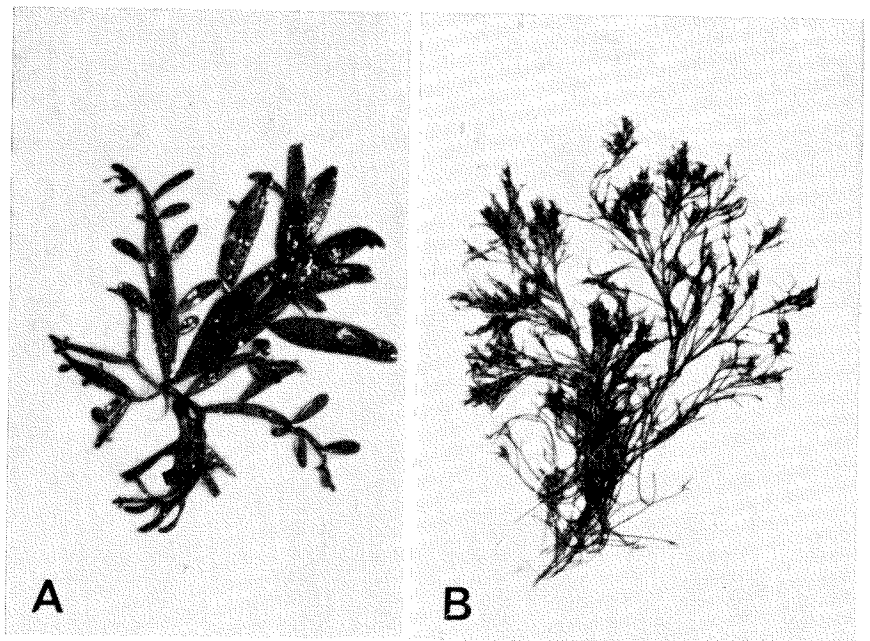


Fig. 13. *Desmarestia viridis*. A typical specimen from 12 m depth south of Surtsey, August 28 1971; nat. size 25 cm.

Fig. 14. A. *Lomentaria orcadensis*. A typical specimen from about 15 m depth southwest of Surtsey, August 28 1971; nat. size 4 cm.
 B. *Polysiphonia urceolata*. A specimen collected at 10 m depth south of Surtsey, August 28 1971; nat. size 9 cm.



the North Atlantic (Cardinal, 1964). Of special interest is the occurrence of *Rhodophysema elegans*, found off the south coast of Surtsey. This species is the first one of the deep water crustose red algae found to colonize the island. Crustose coralline algae were not found in spite of thorough search. The presence of *Chorda filum* and *Chorda tomentosa* at Surtsey is rather unexpected as these species have not been found growing in the Westman Islands. The former is, however, a common driftweed on Surtsey and Heimaey. A similar unusual occurrence of *Chorda tomentosa* has been reported (as *Halosiphon tomentosum*) from new lava flows in Jan Mayen (Gulliksen 1974). Other species, such as *Plocamium cartilagineum* and *Lomentaria clavellosa*, are common deep water red algae in the area and were already presumed as likely colonizers (Jónsson, 1967).

A total of 50 species of macroscopic algae have been identified in the marine environment of Surtsey since the beginning of the colonization 13 years ago. This represents about 42% of the total number of macroscopic algal species found to grow in the Westman Islands. It appears that the marine algal colonization as a whole has been taking place by progressive immigration of species (Table II and Fig. 16). However, year-to-year variations in species composition have been observed during this period. This may be due to seasonal periodicity of short-lived algae and/or to the presence of opportunistic species. Also the possibility that individual species have been overlooked in the field should not be ruled out, especially in the subtidal region. The length of time spent collecting underwater is only 20-

30 minutes for each dive. One must work quickly and there is little time to explore vast areas looking for rare species. In addition, dives are often extremely difficult and even dangerous owing to surge and heavy swell.

Among the algal species colonizing Surtsey, 23 were found in the littoral zone and 31 in the

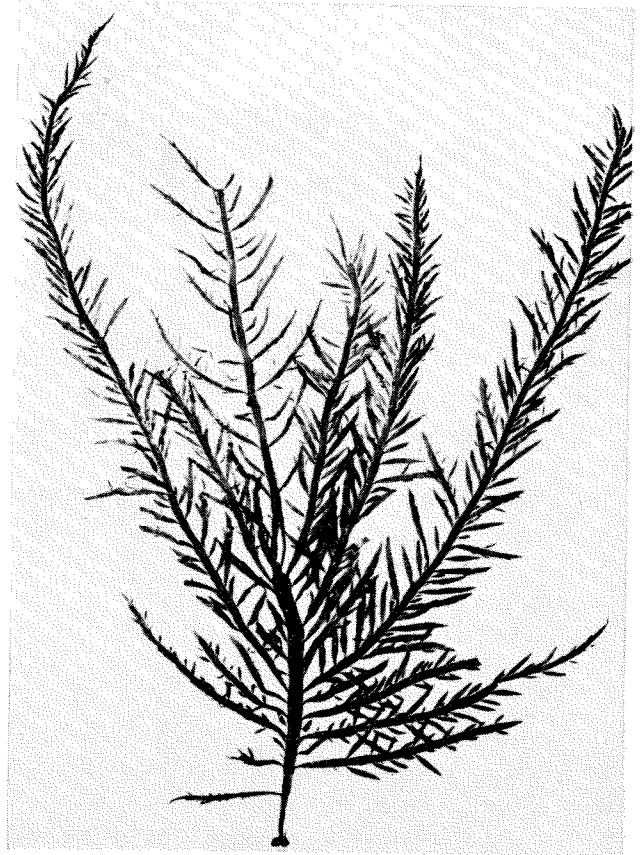


Fig. 15. *Desmarestia ligulata*. A typical specimen from 10 m depth east of Surtsey, August 25 1971; nat. size 70 cm.

TABLE II Marine algae and their order of arrival as recorded at Surtsey 1964-1977.

Species or groups	1964	1965	1966	1967	1968	1969	1970	1971	1977
<i>Diatoms</i>	+	+	+	+	+	+	+	+	+
<i>Urospora penicilliformis</i>		+	+	+	+	+	+	+	+
<i>Ulothrix flacca</i>			+	+	+	+	+		
<i>Ulothrix pseudoflacca</i>			+	+	+	+	+	+	+
<i>Enteromorpha flexuosa</i>			+						
<i>Enteromorpha intestinalis</i>			+						
<i>Pylaiella littoralis</i>			+						
<i>Ectocarpus confervoides</i>			+	+	+	+	+	+	+
<i>Scytosiphon lomentarius</i>			+	+	+	+		+	+
<i>Petalonia fasciata</i>			+	+	+	+	+	+	+
<i>Petalonia zosterifolia</i>			+	+	+	+	+	+	+
<i>Alaria esculenta</i>			+	+	+	+	+	+	+
<i>Porphyra umbilicalis</i>			+	+	+	+	+	+	+
<i>Codiolum gregarium</i>			+	+	+	+	+	+	+
<i>Enteromorpha linza</i>				+	+				
<i>Enteromorpha compressa</i>				+	+	+	+	+	
<i>Acrosiphonia arcta</i> (= <i>A. spinescens</i>)				+	+	+			+
<i>Giffordia hincksiae</i>				+	+	+	+		
<i>Desmarestia viridis</i>				+	+	+	+	+	+
<i>Ulothrix consociata</i>					+	+	+		+
<i>Urospora wormskioldii</i>					+	+			
<i>Enteromorpha prolifera</i>					+	+	+	+	+
<i>Monostroma grevillei</i>					+			+	+
<i>Laminaria hyperborea</i>					+	+	+	+	+
<i>Desmarestia ligulata</i>					+	+	+	+	+
<i>Desmarestia aculeata</i>					+			+	+
<i>Porphyra purpurea</i>					+				
<i>Porphyra miniata</i>					+	+	+	+	+
<i>Lomentaria orcadensis</i>					+		+	+	+
<i>Antithamnion floccosum</i>					+	+	+	+	+
<i>Phycodrys rubens</i>					+	+	+	+	+
<i>Polysiphonia urceolata</i>					+	+	+	+	+
<i>Giffordia granulosa</i>						+		+	+
<i>Blue-Green Algae</i>							+		+
<i>Ulva lactuca</i>							+	+	
<i>Laminaria digitata</i>							+	+	
<i>Euthora cristata</i>							+		+
<i>Derbesia marina</i>								+	+
<i>Pseudentoclonium submarinum</i>								+	
<i>Ulothrix subflaccida</i>								+	
<i>Giffordia secunda</i>								+	+
<i>Ralfsia</i> sp.								+	
<i>Rhodochorton purpureum</i>								+	
<i>Delesseria sanguinea</i>								+	+
<i>Ectocarpus siliculosus</i>									+
<i>Giffordia ovata</i>									+
<i>Giffordia recurvata</i>									+
<i>Chorda filum</i>									+
<i>Chorda tomentosa</i>									+
<i>Plocamium cartilagineum</i>									+
<i>Rhodophysemia elegans</i>									+
<i>Lomentaria clavellosa</i>									+
<i>Antithamnion plumula</i> v. <i>boreale</i>									+
<i>Conchocelis rosea</i>									+

sublittoral zone. Of these, 4 species have settled in both zones. A striking fact is that the colonization in the littoral zone has not progressed markedly since the occupation by some pioneer species as early as 1966 (Fig. 16). A similar

observation has been made for intertidal pioneer populations of algae on lava flows in the Hawaiian Islands (Doty, 1967). This situation may be ascribed to the harsh environmental conditions in the intertidal zone. The most important limiting

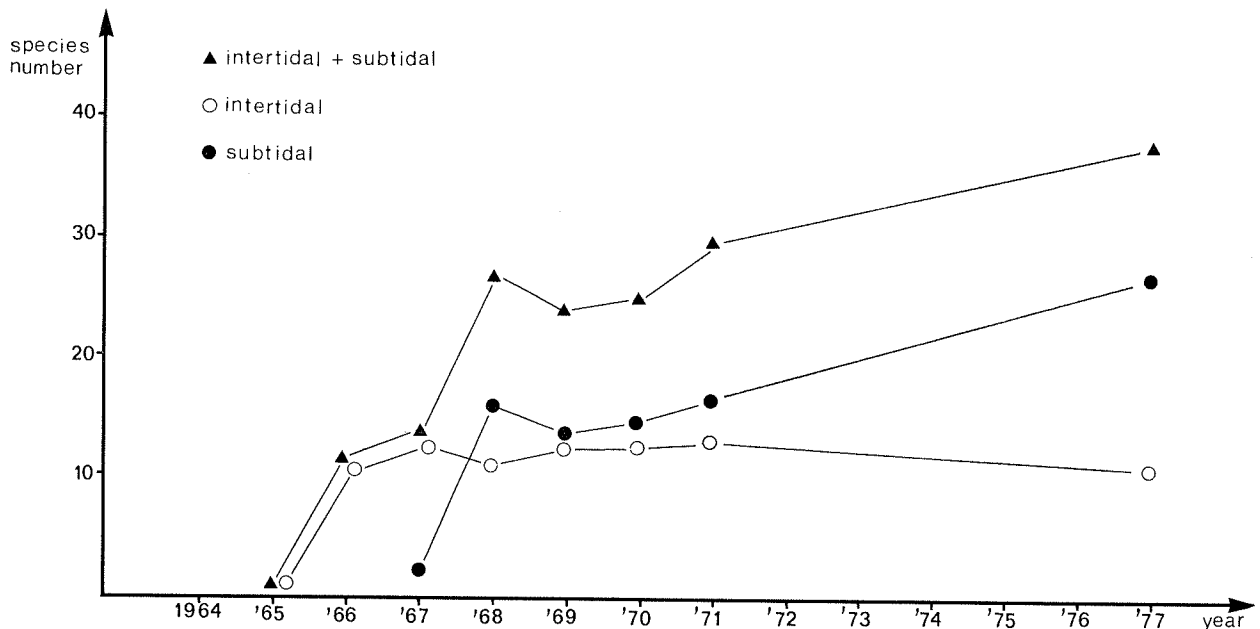


Fig. 16. The number of species of marine algae (diatoms not included) recorded from Surtsey since the beginning of the settlement; note the stationary situation in the intertidal zone contrasting with a progressive colonization in the subtidal zone.

factors are presumably the scouring action by sand and pumice, in addition to the mobility of the substrate due to wave abrasion along the lava cliffs and movement of abraded material. It may therefore be expected that the pioneer stage in the littoral zone of Surtsey will last until the stability of the substrate has been reached. As a contrast to this situation the algal colonization of the sublittoral zone has been progressing faster although starting later (Fig. 16). The difference may be attributed to a more stable environment.

As stated above, only a few subtidal species are actually of ecological importance. These are *Alaria esculenta*, *Laminaria hyperborea* and *Desmarestia viridis*, which were first recorded in 1966, 1967 and 1968, respectively. It is to be noted that the colonization by these species at Surtsey has not proceeded by seral stages of succession similar to those described for artificially or accidentally denuded plots in old floral areas (den Hartog, 1959, Norton and Burrows 1967). Probably, no competitive relations of species will set in as long as there are sufficient vacant places for the new colonizers and their descendants. This problem must be solved on a quantitative basis.

ACKNOWLEDGEMENTS

Thanks are due to Dr. Bernadette Caram who identified the brown algae during the 1971 field trip to Surtsey and to Erlingur Hauksson who participated in the diving work. Our thanks go

also to Erlingur Hauksson, Jóhannes Briem, Jón Ólafsson, Konrád Thórisson, Óli R. Sumarlíðason and Sigurdur V. Hallsson for their assistance during dives in 1977.

The field work was partly sponsored by the Icelandic Science Fund. and by the Surtsey Research Society. R/V Árni Fridriksson was provided by the Marine Research Institute, Reykjavík, during the 1977 field work.

ADDENDUM

Since the preparation of this paper the marine benthic diatoms collected in Surtsey during the survey in 1977 have been worked up by Marie-France Simon, Laboratoire de Biologie Végétale Marine, Paris University. The species identified are given in the following list. Many of these have been previously reported from Iceland (E. Østrup: Marine Diatoms from the coast of Iceland, Bot. Icel., 2: 347-398, 1918). New records are printed in *italics*.

Amphipleura rutilans (Trentepohl) Cleve; littoral W.

Amphora turgida Greg.; littoral E.

Biddulphia obtusa (Kützing) Ralfs; littoral W.

Grammatophora marina (Lyngbye) Kützing; sublittoral W.

Grammatophora serpentina (Ralfs) Ehrenberg v. *pusilla* (Greville) Peragallo; sublittoral W.

Isthmia enervis Ehrenberg; sublittoral E.

Licmophora abbreviata Agardh; littoral E.

Licmophora communis (Heiberg) Grunow; littoral W.
Licmophora hyalina Kützing; littoral W.
Licmophora jurgensii Agardh (=L. oedipus (Kütz.) Grunow); littoral W.
Navicula gracilis Ehrenberg; littoral E.
Navicula grevillei (Agardh) Cleve; sublittoral W.
Navicula lanceolata (Agardh) Kützing; littoral E.
Navicula lanceolata v. *phyllepta* (Kützing) Cleve; littoral E.
Navicula ramosissima (Agardh) Cleve; littoral and sublittoral E and W.
Navicula tenuis (Agardh) A. Cleve; littoral E.
Nitzschia migrans Cleve; littoral W.
Rhabdonema adriaticum Kützing; littoral and sublittoral W.
Synedra investiens W. Smith; littoral E and W.
Synedra pulchella (Ralfs.) Kützing; littoral W and E.

References:

Caram, B. and S. Jónsson, 1972. Nouvel inventaire des algues marines de l'Islande. Acta Bot. Islandica, 1: 5-31.
 Caram, B. and S. Jónsson, 1973. Sur la présence du *Derbesia marina* (L.) Kjellm. en Islande. Acta Bot. Islandica, 2: 25-28.
 Cardinal, A., 1964. Etudes sur les Ectocarpacées de la Manche. Beih. Nova Hedwigia, 15: 1-86.
 Doty, M. S., 1967. Pioneer intertidal population and the re-

lated general vertical distribution of marine algae in Hawaii. Blumea, 15(1): 95-105.
 Gulliksen, B., 1974. Marine investigations at Jan Mayen in 1972. Det Kgl. Norske Videnskabers Selskab Muscet. Miscellanea 19: 1-46.
 Hartog den, C., 1959. The epilithic algal communities occurring along the coast of the Netherlands. North-Holland Publ. Company, Amsterdam, 241 p.
 Jónsson, S., 1966. Initial settlement of marine benthic algae on the rocky shore of Surtsey, the new volcanic island in the North Atlantic. Surtsey Res. Progr. Report, 2: 35-44.
 Jónsson, S., 1967. Further settlement of marine benthic algae on the rocky shore of Surtsey. Surtsey Res. Progr. Report, 3: 46-56.
 Jónsson, S., 1968. Survey on the intertidal and subtidal algae on Surtsey in 1967. Surtsey Res. Progr. Report, 4: 67-73.
 Jónsson, S., 1970a. Studies on the colonization of marine benthic algae at Surtsey in 1968. Surtsey Res. Progr. Report, 5: 42-51.
 Jónsson, S., 1970b. Meeresalgen als Erstbesiedler der Vulkaninsel Surtsey. Schr. Naturw. Ver. Schlesw.-Holst., Sonderband : 21-28.
 Jónsson, S., 1972. Marine benthic algae recorded in Surtsey during the field seasons of 1969 and 1970. Surtsey Res. Progr. Report, 6: 75-76.
 Jónsson, S. and K. Gunnarsson, 1978. Botnþörungr í sjó við Ísland: greiningalykill. Hafrannsóknir, 15: 5-89 (Marine benthic algae of Iceland : identification keys ; in Icelandic).
 Northon, T. A. and E. M. Burrows, 1969. Studies on marine algae in the British Isles. 7. *Saccorhiza polyschides* (Lightf.) Batt. Brit. Phycol. J., 4: 19-53.
 Norman, J. O., B. Calles and R. Å. Larson, 1974. The geomorphology of Surtsey Island in 1972. Surtsey Res. Progr. Report, 7: 61-71.